

REMARKS

Reconsideration of the October 7, 2003, Final Official Action is respectfully requested. Claims 1-4, 6-12 and 14-25 are pending in the application for the Examiner's review and consideration.

By this Amendment, Claims 5 and 13 have been canceled and Claim 1 has been amended to incorporate the subject matter of Claim 13. Specifically, the plasma etch reactor of Claim 1 is now defined as "a capacitively coupled plasma reactor having a powered showerhead electrode and/or a powered bottom electrode."

First Rejection

Claims 24 and 25 were rejected under 35 U.S.C. § 112, first paragraph, for allegedly containing subject matter not described in the specification. In the Official Action, the following position is taken:

Claims 24-25 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter, which was not described in the specification.

In claim 24, "the etchant gas consists essentially of a hydrogen-free fluorocarbon gas, an oxygen-containing gas and optional carrier gas" is new matter because "consists essentially of" excludes other materials. The instantly claimed invention does not have this negative limitation in the disclosure. Furthermore, the disclosure sets forth the C_xF_y is at least C_4F_6 (page 6 of the specification, line 8).

In claim 25, "the etchant gas consists of a hydrogen-free fluorocarbon gas, an oxygen-containing gas and optional carrier gas" is new matter because "consists essentially of" excludes other materials. The instantly claimed invention does not have this negative limitation in the disclosure. Furthermore, the disclosure sets forth the C_xF_y is at least C_4F_6 (page 6 of the specification, line 8).

Official Action, paragraph 1, page 2.

This rejection is respectfully traversed on the basis that no legal precedent is cited in support of the rejection and a similar rejection was reversed in Ex parte Ellul, Appeal No. 1997-4412 (See USPTO official website <http://www.uspto.gov/web/offices/dcom/bpai/decisions/fd974412.pdf>). Ex parte Ellul was an appeal of the final rejection of certain claims reciting "consisting essentially of" polyolefin and plasticizer. The Examiner stated that the specification is directed to a blend of a polyolefin and a rubber taken together with a plasticizer. The Examiner concluded that no support existed for a composition "consisting essentially of" a polyolefin and a plasticizer.

The Board found that the paragraph bridging pages 6-7 of the specification described polyolefin and plasticizer and held that the subject matter of the two components was supported by this description. In view of this, the Board found that appellant was in possession of the invention as claimed, and hence reversed the 35 U.S.C. § 112, first paragraph rejection.

Moreover, the terminology "consists essentially of" in Claim 24 or "consists of" in Claim 25 relates to "transitional phrases" used to define the scope of a claim. See MPEP §2111.03 "Transitional Phrases." Given the explanation of the definition of such phrases in the MPEP, it is submitted that there is no need for such terms to be discussed in the specification.

Claim 24 is directed to an etchant gas consisting essentially of a hydrogen-free fluorocarbon gas, an oxygen-containing gas and a optional carrier gas. Claim 25 is

directed to an etchant gas consisting of a hydrogen-free fluorocarbon gas, an oxygen-containing gas and a optional carrier gas.

Support for the claimed hydrogen-free etch gas can be found in the specification as follows:

Especially good selectivity of oxide to nitride can be obtained when the etch gas is free of hydrogen and/or nitrogen. (Emphasis added, page 17, lines 19-20.)

The fluorocarbon is preferably hydrogen-free and may comprise at least one C_xF_y gas... (Emphasis added, page 18, lines 20-21.)

According to the invention, oxygen is added in an amount effective to control the etch rate selectivity of the etching gas chemistry. That is, the oxygen is effective to prevent etch stop by reacting with polymer at the bottom of the etched openings. The advantageous effects of the invention can be achieved by supplying the oxygen reactant and fluorocarbon reactant to plasma etching reactor at a flow rate ratio of oxygen reactant to fluorocarbon reactant of 1.5 or less. For selective etching of BPSG in a medium density plasma etch reactor, the flow rate ratio of oxygen reactant to fluorocarbon reactant is preferably 0.5 to 1.2...[t]he etching gas mixture may optionally include other gases and/or an inert carrier gas such as argon (Ar), helium (He), neon (Ne), krypton (Kr), xenon (Xe) and mixtures thereof. (Emphasis added, page 18, line 12 through page 19, line 3.)

The process of the invention is useful for obtaining extremely high dielectric:nitride etch selectivity of at least 10:1...For example, etching of a BPSG layer can be carried out for about 1 minute in a single step with... 260 sccm Ar, 12 sccm O_2 , 11 sccm C_4F_6 . (Page 20, lines 9-21).

From the foregoing excerpts and examples from the specification, Applicants respectfully submit that the subject matter of Claims 24-25 does not introduce any new matter, nor does the use of the transitional phrases introduce any new matter. See Ex parte Ellul, supra. The specification clearly discloses a hydrogen-free etch gas and provides an example of an etch gas that consists of C_4F_6 (a hydrogen-free fluorocarbon), oxygen (an

oxygen-containing gas), and argon (a carrier gas). Such a disclosure in the specification demonstrates possession of the etchant gas recited in Claims 24 and 25. In view of the entire specification, Applicants have demonstrated possession of the claimed subject matter recited in Claims 24 and 25. Thus, because the applicants have demonstrated possession of the claimed invention, i.e., an etchant gas that consists essentially of (or consists of) a hydrogen-free fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an oxygen containing gas, and a carrier gas, Claims 24 and 25 are adequately described and the 35 U.S.C. §112, first paragraph, rejection should be withdrawn.

Second Rejection

Claims 1-5, 9-12 and 14-25 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 6,174,451 to Hung et al. ("Hung") in view of U.S. Patent No. 6,074,959 to Wang et al. ("Wang"). The reasons for this rejection are set forth in numbered paragraph 3, on pages 3-7 of the Official Action. This rejection is now moot in view of the incorporation of subject matter from Claim 13 into Claim 1.

Third Rejection

Claims 6-8 and 13 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Hung and Wang in further view of U.S. Patent No. 6,228,438 to Schmitt ("Schmitt"). The reasons for the rejection are set forth in numbered paragraph 4, on pages 7-8 of the Official Action. The Official Action alleges that Schmitt discloses a dual frequency capacitively coupled plasma reactor including an upper showerhead electrode and a bottom electrode (See column 8, lines 1-10) and it is argued that it would have been

obvious to modify the etch process of Hung and Wang to include other commercially available plasma etch reactors. Claim 13 has been canceled, but Claim 1 has been amended to incorporate subject matter from Claim 13. As to Claims 7 and 8, the Official Action acknowledges that "[t]he combined prior art does not disclose the flow rate of oxygen (O₂) for the process" but alleges oxygen is a result-effective process variable. This rejection is respectfully traversed.

1 - Legal Standard for § 103 Rejection

Reconsideration of the rejection is requested in view of the following legal precedent regarding rejections based on a combination of prior art references.

According to MPEP § 2143, to establish a *prima facie* case of obviousness, (1) "there must be some suggestion or motivation, either in references themselves or in the knowledge generally available to one of ordinary skill in the art, to ... combine reference teachings"; (2) "there must be a reasonable expectation of success"; and (3) "the prior art ... references when combined ... must teach or suggest all the claim limitations". The Patent Office has the initial burden of establishing each of these requirements of a *prima facie* case of obviousness. In re Piasecki, 223 USPQ 785, 787 (Fed. Cir. 1984) and In re Warner, 154 USPQ 173 (CCPA 1967).

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. In re Ratti, 123 USPQ 349 (CCPA 1959).

Additionally, if the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. In re Gordon, 221 USPQ 1125 (Fed. Cir. 1984).

2 - Claimed Subject Matter

Claim 1 is directed to a method of *etching a dielectric layer with selectivity to an underlying stop layer*, comprising (a) supporting a semiconductor substrate in a plasma etch reactor, wherein the plasma etch reactor is a capacitively coupled plasma reactor having a powered showerhead electrode and/or a powered bottom electrode, the substrate including a dielectric layer over a stop layer; (b) supplying an etchant gas to the plasma etch chamber; and (c) etching openings in the dielectric layer by energizing the etchant gas into a plasma state, the etchant gas comprising a *hydrogen-free* fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an *oxygen-containing* gas and optional carrier gas.

Claim 7 depends from Claim 1 and further sets forth that the etchant gas is nitrogen-free, the C_xF_y gas is at least C_4F_6 , the oxygen containing gas is at least O_2 and the carrier gas is Ar, the etchant gas being supplied to the plasma etch reactor through a showerhead electrode at flow rates of 2 to 50 sccm C_4F_6 , 2 to 50 sccm O_2 and 50 to 800 sccm Ar.

Claim 8 depends from Claim 1 and further sets forth that the C_xF_y gas is at least C_4F_6 , the oxygen containing gas is at least O_2 and the carrier gas is Ar, the etchant gas being supplied to the plasma etch reactor through a showerhead electrode at flow rates of 10 to 25 sccm C_4F_6 , 5 to 20 sccm O_2 and 50 to 300 sccm Ar.

As set forth below, the combination of Hung, Wang and Schmitt fails to teach or reasonably suggest all of the claim limitations.

3 - The Etch Reactor of Schmitt is Unsuitable for Hung's Process

Initially, it should be noted that Hung and Schmitt relate to incompatible etch processes, Hung disclosing a high-density plasma process and Schmitt disclosing a capacitively coupled plasma process. The Official Action does not explain why a person of ordinary skill in the art would consider the capacitively coupled plasma process of Schmitt relevant to the high density process of Hung. As such, the Official Action fails to establish the necessary motivation to modify Hung to incorporate incompatible teachings from Schmitt.

Regarding Claim 1, Hung relates to a process wherein a high-density plasma etch reactor is used (column 7, lines 33-48 and column 11, lines 1-10). In fact, Hung specifically recites that "[t]he high-density plasma is further important because it produces a higher fraction of ionized etching particles, which can be directed to the bottom of holes with high aspect ratio" (Column 7, lines 45-48). Schmitt relates to a capacitively coupled RF plasma reactor which does not provide a high density plasma. The plasma reactor of Schmitt would be unsuitable for Hung's high-density plasma etch process because it would change the principle of operation¹ of Hung to use a capacitively coupled etch reactor to carry out the modified Hung etch process. Accordingly, because the proposed modification

¹ See MPEP § 2143.01 The Proposed Modification Cannot Change the Principle of Operation of a Reference.

to Hung would change the principle of operation of Hung, the teachings of Hung, Wang and Schmitt are not sufficient to render the claims *prima facie* obvious. See In re Ratti, 123 USPQ 349 (CCPA 1959). Additionally, the proposed modification to Hung, using the non-high density capacitively coupled RF plasma reactor of Schmitt, renders Hung unsatisfactory for its intended purpose². Thus, there is no suggestion or motivation to make the proposed modification. See In re Gordon, 221 USPA 1125 (Fed. Cir. 1984). As such, Claim 1 is patentable over Hung, Wang and Schmitt.

4 - Claims 7 and 8 Are Further Patentable

With regards to Claims 7 and 8, Applicants contend that the addition of oxygen to a hydrogen-free main etchant gas was not known from the teachings of Wang to achieve a recognized result and thus the amount of oxygen to add is clearly not a known result-effective variable. See In re Antonie, 195 USPQ 6 (CCPA 1977) (A particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation). As such, Claims 7 and 8 are further patentable over Hung, Wang and Schmitt.

Fourth Rejection

Claims 1-5, 9-12 and 14-25 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 5,366,590 ("Kadomura") in view of Wang. The

² See MPEP § 2143.01 The Proposed Modification Cannot Render the Prior Art Unsatisfactory For Its Intended Purpose.

reasons for the rejection are set forth in numbered paragraph 5, on pages 8-12 of the Official Action. This rejection is now moot in view of the incorporation of subject matter from Claim 13 into Claim 1.

Fifth Rejection

Claims 6-8 and 13 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Kadomura and Wang in further view of Schmitt. The reasons for the rejection are set forth in numbered paragraph 6, on pages 12-13 of the Official Action. The Official Action alleges that Schmitt discloses a dual frequency capacitively coupled plasma reactor including an upper showerhead electrode and a bottom electrode (See column 8, lines 1-10) and argues that it would have been obvious to modify the etch process of Kadomura and Wang to include other commercially available plasma etch reactors. Claim 13 has been canceled, but Claim 1 has been amended to incorporate subject matter from Claim 13. As to Claims 7 and 8, the Official Action acknowledges that "[t]he combined prior art does not disclose the flow rate of oxygen (O₂) for the process" but alleges oxygen is a result-effective process variable. This rejection is respectfully traversed.

1 - Claimed Subject Matter

Claim 1 is directed to a method of *etching a dielectric layer with selectivity to an underlying stop layer*, comprising (a) supporting a semiconductor substrate in a plasma etch reactor, wherein the plasma etch reactor is a capacitively coupled plasma reactor having a powered showerhead electrode and/or a powered bottom electrode, the substrate including a dielectric layer over a stop layer; (b) supplying an etchant gas to the plasma etch chamber;

and (c) etching openings in the dielectric layer by energizing the etchant gas into a plasma state, the etchant gas comprising a *hydrogen-free* fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an *oxygen-containing* gas and optional carrier gas.

Claim 7 depends from Claim 1 and further sets forth that the etchant gas is nitrogen-free, the C_xF_y gas is at least C_4F_6 , the oxygen containing gas is at least O_2 and the carrier gas is Ar, the etchant gas being supplied to the plasma etch reactor through a showerhead electrode at flow rates of 2 to 50 sccm C_4F_6 , 2 to 50 sccm O_2 and 50 to 800 sccm Ar.

Claim 8 depends from Claim 1 and further sets forth that the C_xF_y gas is at least C_4F_6 , the oxygen containing gas is at least O_2 and the carrier gas is Ar, the etchant gas being supplied to the plasma etch reactor through a showerhead electrode at flow rates of 10 to 25 sccm C_4F_6 , 5 to 20 sccm O_2 and 50 to 300 sccm Ar.

As set forth below, the combination of Kadomura, Wang and Schmitt fails to teach or reasonably suggest all of the claim limitations.

2 - The Etch Reactor of Schmitt is Unsuitable for Kadomura's Process

Initially, it should be noted that Kadomura and Schmitt relate to incompatible etch processes, Kadomura disclosing a high-density plasma process and Schmitt disclosing a capacitively coupled plasma process. The Official Action does not explain why a person of ordinary skill in the art would consider the capacitively coupled plasma process of Schmitt relevant to the high density process of Kadomura. As such, the Official Action fails to establish the necessary motivation to modify Kadomura to incorporate incompatible teachings from Schmitt.

Regarding Claim 1, Kadomura relates to a process wherein a high-density plasma etch reactor is used (column 3, lines 36-44). In fact, Kadomura specifically recites that the fluorocarbon etching gas is in the form of a high-density plasma because of dissociation which takes place more readily than in the case of conventional RF plasma under a low pressure (Column 4, lines 53-58). Schmitt relates to a capacitively coupled RF plasma reactor which does not provide a high density plasma. The plasma reactor of Schmitt would be unsuitable for Kadomura's high-density plasma etch process because it would change the principle of operation of Kadomura to use a capacitively coupled etch reactor to carry out the modified Kadomura etch process. Accordingly, because the proposed modification to Kadomura would change the principle of operation of Kadomura, the teachings of Kadomura, Wang and Schmitt are not sufficient to render the claims *prima facie* obvious. See In re Ratti, 123 USPQ 349 (CCPA 1959). Additionally, the proposed modification to Kadomura, using the non-high density capacitively coupled RF plasma reactor of Schmitt, renders Kadomura unsatisfactory for its intended purpose. Thus, there is no suggestion or motivation to make the proposed modification. See In re Gordon, 221 USPA 1125 (Fed. Cir. 1984). As such, Claim 1 is patentable over Kadomura, Wang and Schmitt.

3 - Claims 7 and 8 Are Further Patentable

Applicants contend that the addition of oxygen to a hydrogen-free main etchant gas was not known from the teachings of Wang to achieve a recognized result and thus the amount of oxygen to add is clearly not a known result-effective variable. See In re

Antonie, 195 USPQ 6 (CCPA 1977). As such, Claims 7 and 8 are further patentable over Kadomura, Wang and Schmitt.

In view of the foregoing, it is submitted that the present application is in condition for allowance and such action is earnestly solicited.

Respectfully submitted,

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